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AR With Cloud Anchors:
A Way to Improve HCI and Interactive Art

João Luís Antunes, Universidade Aberta, Portugal
https://orcid.org/0000-0001-7306-3238
Jose Bidarra, Universidade Aberta, Portugal
Mauro Figueiredo, Universidade do Algarve, Portugal

ABSTRACT

Despite all the potential of augmented reality to improve the human-computer interface (HCI) and the user experience, it's still below the expected usage. The reason may be related to the fact that until recently the AR implementation was mostly marker-based or GPS-based to trigger additional content (video, 3D, or other) to the reality identified with the camera. The research in this paper is focused on AR marker-less solutions that allows sharing AR content between users across the Cloud, based on the anchor identification. With this technological paradigm shift, the potential for use of new functional environments and an unprecedented status of HCI enrichment is achieved. In addition to the operations related to the applications functionality, the door opens for media-art artists to create AR models that can be shared in a multiple user environment across the Cloud.

KEYWORDS

AR, Cloud Anchors, HCI, Mobile Media Art, PWAs

INTRODUCTION

The known futurist Gerd Leonhard (2016), describing his vision for Human-Computer Interface (HCI), predicts that soon much of the interfaces will be done by voice, touch, or AI – no more typing. He mentions a Cisco projection for 2020, that almost 80% of the world's traffic will come via mobile devices. The world is becoming more and more mobile, and based on our own experience as users, possibly Gerd's vision is aligned with reality.

With this paper, we propose to analyze the opportunity given by the introduction of AR with Cloud Anchors in the creation of mobile media-art and how it can improve the HCI and user experience on smartphones and tablets. As a marker-less solution we use Google's ARCore, a solution with the ambition to become the market

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standard, transversal to all operating systems. There are available other solutions such as Apple's ARKit or the Spacial Anchors promoted by Microsoft, that persecute the same objectives and implementation on the Cloud.

The application interface for smartphones is supported on its majority based on installed apps, to accomplish a specific operation. This is a huge impediment for a friendly HCI, without the need to manage hundreds of icons on the screen, and for interaction and sharing information between native applications. Studies confirm that solutions based on native apps suffer a high rate of substitution. According to Google (Tiongson, 2015), one in four apps installed is never used. In another study by the portal Statista[1], it publishes that the percentage of apps in the US that have been used only once since 2010, maintains stable around 25%. That means the abandonment rate with the first use is one in four installations, numbers that corroborate the google statistic.

On the other hand, users like to have the most used applications present in the UI, by commodity and rapid access to the applications, finding that is stimulate by brands for the communication process with user, with the small icon been a kind of "remember me, try me". According this statement everybody is comfortable with the modus operandi, but not really. There are thousands of applications, with a non-recurrent usage that users don´t install, because are impossible to find in a well with millions of applications and they don't want to share the screen with more icons.

During the research that supports the present investigation, work was carried out with two focus group, one with the Lisbon MBA Alumni students, and another with current students from the second year of Marketing Management at IPAM. As a result, from this research it was possible to identify similar behaviors before the technological environment, aligned with the results of the Google study (REF). In both groups, we found users, who uninstalled the applications after satisfying their need of use. The most heard arguments are memory space consumption; slower equipment; management of too many icons in the graphical interface and invasion of privacy.

So, this paper will discuss the development of the technology we believe it's best positioned for change the applets status quo (one app installed; one functionality; one brand). The technological transformation can represent an opportunity for HCI, given the possibility to the app work as a web page with possibility of push information notification.

AR: WHAT IS MISSING?

Augment Reality has been available since the early 1970s, but only now is it beginning to place its full potential in the hands of the average user. Evidence of this was the Pokémon-Go game, a highly immersive form of entertainment, which has brought AR to millions of users who are completely unaware of this technological capability. Despite the success achieved, reality shows that success can be short-lived, with the loss of interest from users in the application and with Nintendo unable to relaunch the product to the level of success achieved. Pokémon-Go life cycle demonstrates that AR applications suffer from the same constraints identified in other applications that are

not leveraged in content. User experience during the journey through technological medium, require constant and diversified stimuli, in a constant information interchange, where the user is making part of the application, adding content and consuming from others. Edmonds (2019) postulated that what one person sees or hears in the machine is always determined by the action of others, people who designed the interface and those who generate contents to the medium.

The consulting company Perkins Coie, has been conducting an annual report focus on Augmented and Virtual Reality, interviewing hundreds of startups, established tech firms, advisers and outside consultants involved with the technology, what turns these reports a very interesting source of information.

The Perkinscoie (2016) report identifies that user experience and missing contents are the biggest obstacles to mass AR adoption. The most recent report from March 2020, Perkinscoie (2020), respondents answering the question "What is the biggest obstacle to mass adoption of AR", the most relevant attribute was "user experience" with 32% of answers, followed by "content offering" with 18%.

As we can verify, the main concerns with AR continues to be user experience and lack of contents, what is a long period for a technology assumed as disruptive, and in constant innovation.

In our annalise, the apparently reason for concerns with user experience is dependent of technological aspects, some inherent to the technology itself, namely:

1. Until recently, technology offers two basic ways to run the AR application: with markers, in which the camera, when interpreting the image of the marker, will run the application it has associated with; by positioning, usually using GPS coordinates as with the Pokémon-Go game. This technological constraint has retained AR within usage boundaries, not converging with the interests of mobility and creative expectations that it incurs.
2. For applications take advantage of hardware, namely smartphone sensors, these developments are made with native applications, which require installation. This limitation conditions a participatory culture with apps dedicated to a specific purpose, such as adding content or experimentation without having to install the application first.
3. Another factor is the support equipment's, like smartphones that only recently started to include hardware, namely cameras and processing with support for AR in a spread way.

The good news is that the leading companies are aware of these limitations and began to design paths that go beyond the limitations presented and raise AR to a new level of development, with each manufacturer trying to avenge its solution in order to gain an advantage in the market. The objectives are common to companies like Google an Apple, which involves developing the potential of technology in areas of high performance, such as electronic commerce and gamming, for example, adding value beyond the reality known in the human-machine interface.

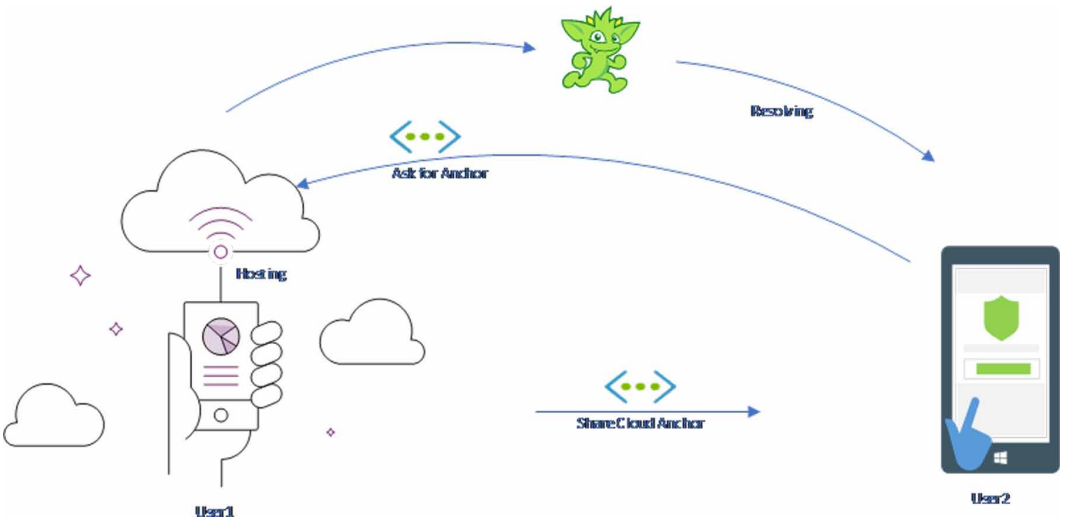
Considering that standards are stabilized, and development platforms are available to support the latest innovations, we propose analyze these innovations and explore how they can overcome concerns about the user experience and the lack of attractive content.

AR WITH CLOUD ANCHORS

Probably one of the biggest technological advances in AR, comes from the introduction of Cloud Anchors, with Google betting on ARCore, Apple on ARkit and Microsoft on Azure to create and share their Spacial Anchors. These technologies generically pursue the same objective, which is to free applications from the chains of markers, and share AR contexts between different users, whether they are in the same physical context or not. We will stress on Google's ARcore for its importance, but also for the unprecedented strategy of making the technology available for the competitor iOS system. According to Google, the technology is so disruptive that it could not be limited to Android, thus preventing two users with different systems from being prevented from sharing AR objects.

Analyzing the case of Google with its ARCore development platform, it is possible to create anchors in the Cloud so that all systems and devices can have access. "Anchors" are access points represented by an identifier, where data is shared for multiple visitors, which gives to Augmented Reality creations the possibility to create a multiuser reality shared on the Cloud. In the case of Google, sharing is facilitated by the creation from the user account of a database of Anchor identifiers in Firebase (Figure 1).

Figure 1. Scheme representing sharing cloud anchors



For hosting and resolving anchors involves these steps at a high level annalise:

1. The user creates a local anchor in their environment.
2. During hosting, ARCore uploads data for the anchor to the ARCore Cloud Anchor service, which returns a unique ID for that anchor.
3. The app distributes the unique ID to other users.
4. During resolving, users with the unique ID can recreate the same anchor using the ARCore Cloud Anchor service.

This technology represents a breakthrough in the potential for using AR, by allowing a smartphone with the ability to resolve AR, without a dedicated app installed can receive and display a 3D image of a new real object. To achieve this level of abstraction, is enough an equipment capable of running the AR service, and installed Google Play Services, which automatically makes features available. In the recent android versions, the user doesn't need install the ARCore service to solve the Anchors like occurred on the previous version, which is a way to facilitate the access to Augmented Reality.

The use of Cloud Anchors solves the first problem presented for technology, dependence on markers or positional reference to rendering AR. The second limitation, the dependency of native applications, that needs installation, has a similar evolution with the introduction of progressive web applications.

THE WAKING UP OF PROGRESSIVE WEB APPS (PWAS)

The necessity to find a substitute or a complement, for the native *apps* technology applications that run on mobile equipment as an installed solution is not new. But only in 2015 the Google engineer Alex Russel and the designer Frances Berriman wrote the manifesto that supports the functional operation of progressive web apps (PWAs). According to Russel, they wrote it after dinner and was Frances who gave it the name of progressive, because according to what they wanted to achieve, as the application is used it should become progressively more efficient. The idealized apps should be supported both by existing browsers and be prepared for the new features of the search engines, which Russel foresaw, and are incorporated today.

PWAs were designed to incorporate the benefit of native and Web applications into this new technology. Its attributes include the possibility of running from a URL and placing it in the user's decision if it desires evolve into an installed app, as well as the possibility of interacting with the equipment's hardware and push notifications, which allow the server dynamically renew content to application.

The list of attributes recognized as part of the PWAs definition, presents the same basic structure as that defined by Chrome development engineer Alex Russel, where he mentions that PWAs should work in in terms of navigation and interactions like a native app, adopting a shell philosophy separate from "content" as architecture. This attribute represents the philosophy of distributed architecture separating what is

code from the contents, which means that they can be dynamically changed without impacting the coded technical functionalities.

- Discoverable - content can be discovered on the Web by search engines, the benefit of the web app manifest mechanisms.
- Installable - can be installed like any application, without the need to use an app store. It is not dependent on the operating system it runs on, but it can be installed as a native app.
- Linkable - can be shared as a simple URL.
- Independent network - can operate offline or with a very poor-quality network.
- Progressive - works independently of the browser used, with the possibility of improving progressively with the functional cache and the separation between shell and content,
- Upgradeable - using the service workers mechanism, it is able to send updates directly from the server to the app, which allows push notifications.
- Responsible - uses techniques that ensure that the interface pages adapt to any interface of the current equipment or another that appears in the future supported on the same Web technologies.
- App-like-interactions: adopt a Shell plus Content application model to create appy navigations & interactions.
- Secure - the server uses HTTPS to guarantee content security and URL validation.

The technology was identified as so significant that it quickly ceased to be limited to Chrome and started to be supported by Web browsers, such as Firefox, Opera, Microsoft Edge. Other manufacturers are also incorporating it in their browsers, such as Samsung and Apple, which abandoned its development solution and just introduced PWAs in iOS 13 to be supported by Safari.

The widening of the usage spectrum, to Google's competitors, allows us to conclude that we are facing a technology with great potential to become a standard, which solves a large part of the problems that today arise for native apps.

The second problem identified as limiting the progression of AR, is solved in an extremely elegant way, by allowing an application to live as a Web App based on a link and solved in a browser, or to be installed as a native app. It is passed to the user the power through a button available in the application the decision based on recurrence of use or preference, he can choose whether to install as a native app.

JOINING CLOUD ANCHORS AND PWAS

The technological advances introduced by Cloud Anchors and PWAs not only facilitate the user's experience with AR, but also improve the development and maintenance of applications that integrate these technologies. However, the fact that the technology is available does not mean that it is easily accessible and usable by programmers, let alone by artists who may not be proficient in the means of programming.

To respond to the need to make basic operations easily programmable, the W3C consortium wrote the WebXR specification for Augmented Reality and Virtual Reality, to create an application layer that virtualizes the main interaction commands with the equipment. WebXR is a web API, which allows web pages to interact with AR and VR devices to perform operations such as:

- Get device position and rotation;
- View images on the device;
- Handle AR controller events (for example, buttons or lever axis);
- Obtain the position and rotation of the controllers;
- Consult device AR resources;

This allows users to view and interact with immersive content without having to download an application. They can simply navigate to a website that speaks to the WebXR API.

The disruption that brings the solution, is the fact that the necessary technology is a browser, browsing the web. No specific browser extension is required, or a native application installed. As google presents it with these words, "it's just the web".

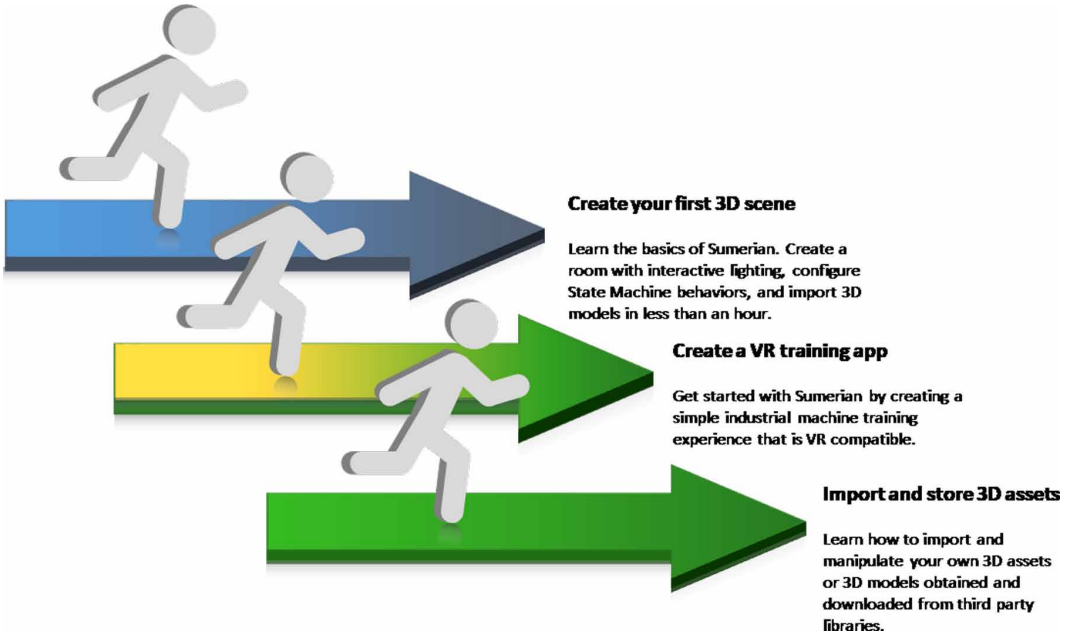
ONE STEP AHEAD

Despite all the ease creation of AR that the presented mechanisms provide, there is a wide range of creators, especially in the artistic and graphic design fields with little programming knowledge, but with creative expertise and the participation desire to the medium. This space proved to be attractive to Amazon, which was already betting on content and processing in the Cloud with Amazon Web Services. In 2018 they presented the new product called Amazon Sumerian, a toolkit and platform for developers to build "mixed reality" apps. That means using virtual reality, Augmented Reality and 3D, without needing to have any specialized programming or graphics skills. Since Sumerian [2]was introduced, it has undergone considerable improvements, and today it is one of the most interesting solutions to combine the most avant-garde developments of AR in the same product.

The main differentiating argument of the solution is undoubtedly the ease of creation that the platform allows, which starts right at the first step presented on the company's website, dedicated to the creation of 3D images, without resorting to complex tools such as Blender or 3ds MAX.

The description of the three operations is taken from the Amazon Sumerian website, but not the picture. The text was integrated in a graphical image, to better conveys the sequence of the creative process and the speed of execution. One interesting aspect of the conception architecture, is if the creative wants achieve more complex effects and creations, can take advantage of programming mechanisms by editing the JavaScript (Figure 2).

Figure 2. Resume of creative process with Amazon Sumerian



To encourage the service Sumerian adoption, it's possibly a free account creation valid for one year, which is very interesting for students and artists who intend to explore the potential of the service.

IMPACT ON HCI AND INTERACTIVE ART

What we have just noticed with this technological report, is that the creative and productive process of Augmented Reality is potentially dynamizing itself in two fundamental vectors for its growth, which brings the technology to any user:

- Ease of development, which made the integration of objects and their manipulation much simpler;
- Can be represented without any specific additional support. This vector can be for AR as the WWW was for the internet. Navigating and viewing AR is now available in the same environment without borders or limitations.

The expected impact on the creative community of artists, and on the user's experience, is so exciting that an authentic revolution is expected. But this transformation goes beyond the creativity of Augmented Reality as media art, or the representation of a 3D object, with the most diverse purposes linked to the observer's journey, as is the case with electronic commerce. The so-called fine art, like painting or sculpture, has an unprecedented representation environment, as well as access to information that complements the discovery of the work as never before achieved.

To exemplify the potential of WebXR applicability, Google under the Arts & Culture program has developed an AR application that uses Chacmool, a mythical figure from ancient Mexico represented by a seated human sculpture. The result of this work can be viewed on a youtube record or try directly the application (Figure 3).

Figure 3. Source google developers: https://www.youtube.com/watch?v=Zu6MXyfi-Ts&feature=youtu.be

The application starts by visualizing the real surroundings, where it signals a rectangle to the scale of the figure in the physical space where its position is. The user checks the placement of the outline of the image on the floor of the room, chooses the most appropriate place and presses the "tap to place" button. The Chacmool figure appears on a scale framed with surrounding space, the user being able to move the image, or obtain additional information at the marked points that complement the interpretation of the work.

This way of obtaining a richer view of the artifact, meets what Edmonds (2007) defines that the interactive art is distinguished by its dynamic "behavior" in response to external stimuli, such as people moving and speaking. The museum can come to our house where instead of just talking about the stature of a historic figure, it´s possible to see them rendered in 3D space right in front of us. And none of this would require an app or install of any sort. All we need is your browser and a URL.

The conditions to spread the technology are summarized in the words of Williams (2017) a technology journalist and writer: "For any platform to succeed, the barrier needs to be sufficiently low that artists can experiment with it freely, and expanded tooling is essential to attracting more people into creating for the medium".

The good news for artist and developers in general, is never like now the conditions are realized and each one can start your way through the Augmented Reality. Through these innovations, artists have been given the capacity to transport audiences into complex meshworks of narrative and experience (Wright, 2018).

CONCLUSION

In ancient Greece, art was part of the individual's daily life, either privately in wealthier homes or in public spaces, where sculpture, poetry and rhetoric were a form of cultural manifestation. Evolution to the modern age is characterized by the removal of art as an aesthetic element for the closed spaces of museums, where the observer moves with the explicit objective of observing and interacting, allowing himself to be touched by the artefact.

Time becomes a fundamental variable in the aesthetic experience of interaction with the work, the observer moves in the exhibition space, casting a fleeting glance at each work without exploring the feeling that his imagination allows to infer in the here and now of the time. The evolution of Augmented Reality brings a new perspective of interaction between the observer and the work, revolutionizing not only new forms of media art that has become an embedded part of everyday life (Hjorth, 2015), but also the fine arts, such as the Chacmool demonstrated by Google, and presented in this paper as realized example. The observer will have all the time to take a deep look in the work, obtain the reference points that define it, assimilate the information placed in the work to facilitate its interpretation. Dewey (1934), wrote that when artistic objects are separated from both conditions of origin and operation in experience, a wall is built around them that renders almost opaque their general significance, with which esthetic theory deals. The analyzes of the current state of the technology, and realized experiences, permits us conclude that augmented reality can incorporate value for both Dewey (1934) conditions, given a new user experience that overcome a fleeting look to the artefact.

The increment of art presence and creativity based on AR in the HCI, will bring more harmonization for the interface human machine, even if dedicated to specific industrial application. The doors are open, and the conditions created, when the technological barriers drop down and art can flow in all its splendor.

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ENDNOTES

1 Mobile apps: percentage of mobile apps that have been used only once in US, 2010-2019: https://www.statista.com/statistics/271628/percentage-of-apps-used-once-in-the-us/

2 Amazon Sumerian: https://aws.amazon.com/pt/sumerian/

José Bidarra has a PhD in Educational Communications by Universidade Aberta (the Portuguese Open University), where he is currently Professor with Habilitation in the Department of Science and Technology. For many years he was head of the Informatics, Physics and Technology Section (SIFT) and has been director of Master and PhD programs. He is also co-author of the virtual pedagogical model used at Universidade Aberta. His current research interests focus mainly on the application of multimedia and digital media in distance education, including ebooks, games and simulations. Many of his master and doctorate students are developing new methodologies to engage learners in valuable experiences with digital media. Most of the research is conducted at Universidade Aberta and at CIAC (Center for the Arts and Communication Research, University of Algarve); other research includes a Honorary Fellowship at the Games, Learning, and Society research unit, University of Wisconsin – Madison (USA), and frequent collaborations with European universities and networks: TU Graz, OU-NL, OU-UK, EADTU, EMPOWER, SmartLearning DK.